

The University of Chicago

MEDIATE ASSOCIATION

A DISSERTATION SUBMITTED TO THE
FACULTY OF THE DIVISION OF THE BIO-
LOGICAL SCIENCES IN CANDIDACY FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF PSYCHOLOGY

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By

HENRY NELSON PETERS

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MEDIATE ASSOCIATION¹

BY HENRY N. PETERS

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I. INTRODUCTION

That the conventional laws of association between ideas were in need of some form of supplementation was recognized early, and the concept of mediate association was suggested. In his *Treatise of Human Nature* Hume made the following observation: "That we may understand the full extent of these relations, we must consider, that two objects are connected together in the imagination, not only when the one is immediately resembling, contiguous to, or the cause of the other, but also when there is interposed between them a third object, which bears to them any of these relations."² Hartley also saw the need of some such concept to explain all the apparent relationships between ideas.

Hamilton, however, contributed the first clear analysis of the concept and also related the now classical example of mediate association from his own experience.³ He maintained that the successive appearance of apparently unrelated ideas in consciousness can be accounted for only on the basis of a third idea which is definitely related to both of them. This third idea may be (1) conscious for an instant and immediately forgotten (as Stewart maintained) or (2) unconscious. Hamilton felt in agreement with Leibnitz concerning the existence of unconscious ideas, and accordingly took the latter alternative.

According to Hamilton's analysis, the term 'mediate association' refers to an indirect associative connection be-

¹ The writer is indebted to Dr. Harvey A. Carr for suggesting the problem and first method used in this dissertation and for valuable criticisms of the first manuscript.

² D. Hume, *A Treatise of Human Nature*, p. 320, London, Longmans, Green and Co., 1886.

³ Sir W. Hamilton, *Lectures on Metaphysics*, Vol. I, pp. 351-354; Vol. II, pp. 244-245, Edinburgh and London, William Blackwood and Sons, 1859.

tween two items of experience, ideas, or mental acts, as opposed to a direct type of associative connection. And this indirect associative connection is one supposedly mediated by a third item that has been directly associated with both of them. When we find two ideas A and B appearing in succession with no possibility of their previous, direct association, we will usually find that both A and B have formerly been associated with an item C .⁴ Thus, the connection $A-B$ is the result of two other connections, $A-C$ and $B-C$. However, in spite of this very definite statement of the meaning of the term, it is noteworthy that in the writings on so called 'mediate association' the term is used in various ways.

In the first place, there is the question of whether the common mediating item is conscious or not. On the one hand, some writers insist that the crucial point is that the common item be unconscious; and others, that a mediate association is one in which the mediate factor occurs in consciousness but is only dimly perceived or unnoticed. Hamilton held the former view. The latter view was accepted by Wundt.⁵ Apparently, according to Wundt, in mediate association there is no $A-B$, but an $A-C-B$ connection.

Some writers have used the term to express any associative connection that is mediated by a physiological, or neurological, and, therefore, unconscious element. When A and B appear together in consciousness, the neural elements with which they are correlated are joined by the neural element of C . This definition really amounts to a neurological statement of Hamilton's standpoint. Atherton and Washburn use the concept in this sense.⁶

Titchener, as Atherton and Washburn point out, uses the term in the physiological sense, but in a fashion that is unique.⁷

⁴ Sir W. Hamilton, *Lectures on Metaphysics*, Vol. I, pp. 351-354, Edinburgh and London, William Blackwood and Sons, 1859.

⁵ W. M. Wundt, *Sind die Mittelglieder einer mittelbaren Association bewusst oder unbewusst?* *Philosophische Studien*, 1894, 10, 326-328.

⁶ M. V. Atherton and M. F. Washburn, *Mediate associations studied by the method of inhibiting associations: an instance of the effect of 'Aufgabe,'* *American Journal of Psychology*, 1912, 23, 101-109.

⁷ E. B. Titchener, *A Text-Book of Psychology*, p. 386, New York, Macmillan Co., 1910 (revised).

The following hypothetical example, to be found in his text-book, explains what the concept means for him: An individual, on two separate occasions, observes two pictures which are done by the same painter; in neither instance does he consciously apperceive the painter's name in the corner; the second picture, nevertheless, reminds him of the first. The signature of the painter has acted as mediator between the two pictures. In neither instance was the signature conscious, but it must have left an impression on the nervous system which, when aroused, served as mediator between the two conscious items on the second occasion. No other writer or investigator in the literature has used the term in exactly this sense.

Still another sense in which mediate association has been very frequently used is that of the arousal of an idea by a present, but unnoticed, sensory experience. The chief difference between this definition and Titchener's is that it is not necessary that the sensory stimulus be one that has never been conscious. This definition accounts for the arousal of *B* in terms of an unconscious *C*, rather than the connection between *A* and *B* in terms of an unconscious *C*.

Mediate association has also been used in the sense of remote association, or in the sense of 'mediate successive association' that Ebbinghaus deals with in his *Ueber das Gedächtnis*.⁸ Remote association refers to an associative connection between *A* and *B* by virtue of the fact that they have been learned in the sequence *A—C—B*. For mediate association, the previous associations need not necessarily be successive ones. Although certain writers have used the term mediate association in the sense of remote association, they have recognized that they were using it in a sense different in certain respects from previous usage.⁹

This divergence of opinion as to the nature of mediate association is attested by Piéron in his theoretical discussion of the subject in the *Revue Philosophique*, 1903.¹⁰ The chief

⁸ H. Ebbinghaus, *Ueber das Gedächtnis*, p. 139, Leipzig, Duncker & Humblot, 1885.

⁹ See, e.g., F. Nagel, Experimentelle Untersuchungen über Grundfragen der Assoziationslehre, *Archiv für die gesamte Psychologie*, 1912, 23, 156-253.

¹⁰ H. Piéron, L'association mediate, *Revue Philosophique*, 1903, 56, 142-149.

divergence in defining the term has been over the question of whether the common item is consciously present during the appearance of the mediate association or not. Hume, Hamilton, Myers,¹¹ and the majority of the experimenters have leaned toward the opinion that defines mediate association in the narrower sense as an indirect association between items, the common term being non-conscious. Wundt, Aschaffenburg, and others have used the same terms to describe an indirect association between two items, the intermediate, common item being conscious. The latter view holds that the common item is conscious only to a slight degree, unattended to, or not apperceived.

The usages and definitions of the term mediate association thus differ. Since definitions of terms are arbitrary, it is futile to select any one of these definitions as the true and correct one. Consequently we shall select three typical definitions of the term, and discuss the truth of each of these three concepts in the light of our experimental findings.

1. The first may be termed an objective definition. Will two items, *A* and *B*, tend to recur together or in immediate succession in virtue of the fact that both have been previously associated with a common item *C*? It is to be noted that this definition makes no assumptions as to the mechanism of arousal; it makes no assumptions as to the presence or absence of *C* at the time of recall; and it makes no definite assumptions concerning a stimulus-response relation between *A* and *B*.

2. Because of their previous association with a common item *C*, will the presence of *A* arouse *B* when *C* is not present? This definition differs from the first in that *A* is assumed to be the stimulus which arouses *B*, and that *C* is not present at the time of recall. This definition of the term is the one adopted by Hume and Hamilton.

3. When two items *A* and *B* have been associated with a common item *C*, will thereafter the presence of *A* first arouse *C* and thus indirectly arouse *B*? This definition differs from the second in respect to the mechanism of arousal. *B* is

¹¹ C. S. Myers, *A Text-Book of Experimental Psychology*, pp. 159-160, Cambridge, University Press, 1922.

aroused by the presence of *C* and *C* in turn was aroused by *A*. The stimulus-response sequence can thus be represented by the symbol *A—C—B*.

The concept of mediate association does not assume that *B* will recur every time that *A* is present. In the course of experience the item *A* has become directly associated with a great many items, and naturally *A* is more likely to revive some of these items rather than any of those with which it is mediately connected. The concept presumes that mediate revival will be an occasional event which occurs only under favoring circumstances. What are these favoring circumstances? Will it occur only for certain materials—logical material as opposed to nonsense material? Will it occur more frequently for certain individuals—for example, those who have developed certain habits of thought? Will it occur only for certain behavior situations which involve a predisposing mental set at the time of recall? Any experimental test of the truth of the concept must take into consideration the nature of these predisposing conditions.

Experimental tests of mediate association, with one exception, have given negative results.¹² The general method used has been as follows: The subject was given one exposure of a list made up of pairs of *A—C*'s and *B—C*'s, the *C* items being common to two pairs. The subject was then presented with a list of *A*'s or *B*'s or both and instructed to name the first idea coming to mind. The resulting amount of mediate association was compared with the amount allowed by chance.

These experiments were defective in two respects. (1) The paired items were exposed but once, and there was no subsequent recall test to ascertain whether these associations were established or not. At best only a few associations could have been established and these not very strongly. There is thus no guarantee that these basic connections were effectively established. (2) They assumed that the two items that were presented with the common item had never been directly connected with each other in times past, but the only evidence for this assumption is that of memory. A control

¹² See references.

experiment should have been performed upon another group of subjects in which the final recall test was given without the previous exposures of the pairs. The number of 'correct' recalls found by such an experiment would be the result of chance plus the direct associations which have been formed between the items by previous experience.

II. THE EXPERIMENTS

PART I

This experimental section is divided into two parts. In the six experiments to be described in the first part, one general method was used. Two lists of paired associates were formed, one of the items of every pair in one list being identical with one of the items in the other list. One list, thus, was a series of *A—C*'s; the other, a list of *B—C*'s. Each pair in both of the lists was composed of a common item and a non-common item. In making up these lists, the same kind of material was not used for all items: the *A*'s, the *B*'s, and the *C*'s were each of a different type of material. For instance, in one experiment, words were used for *A*'s, letters of the alphabet for *C*'s, and numbers for *B*'s. Thus, the first list was a series of words paired with letters; and the second list was a series of numbers paired with the same letters. The subject was required to memorize both of these lists in succession by the paired associate method. According to this method, each exposure of the list of pairs was followed by an exposure of a list of the instigating items. When the single items alone appeared, the subject attempted to name as many of the associated items as possible. These alternate exposures of the paired and single items were continued until the subject had memorized to the point of three perfect recalls. After the second list was learned, a list of single, non-common items of one of the lists of pairs was exposed and the subject was given instructions to name the first item of the class of material that made up the non-common items of the other list that comes to mind. In short, after learning an *A—C* list and a *B—C* list, the subject is presented with the list of *A*'s and instructed to name a *B*. For instance, to return to the above example, after learning

paired words and letters, and paired letters and numbers, the subject is presented with the list of words only, and instructed to name the first number coming to mind.

In each of the following six experiments introspective reports were taken in the form of answers to definite questions. The questions were formed in such a fashion as to determine whether the subject was (1) aware of the mediate, common, item while making his recall and whether or not he was (2) aware of the nature of the set-up of the two lists he had memorized in succession, *i.e.*, that according to the arrangement two different items were being associated with an identical common item. It is a fair assumption that if the subject is not aware of the second factor he did not directly associate, during learning, the pairs of non-common items according to identical common item.

Experiment I

Procedure.—The subject first learned a list of twenty paired words and letters. The words were in the position of stimulus; the letters, in the position of response. Immediately afterwards, he learned in the same manner a list of twenty pairs of numbers and letters. The letters were the same ones used in the first list; the numbers were from one to twenty. The letters were in the position of response. Thus, the common item for these two lists was the response. The pairs were exposed on an electrically operated memory drum. The exposure time for each pair was two seconds. Place associations were eliminated by presenting the materials in random orders. The criterion of learning was three perfect trials in succession. Twenty-four hours after the completion of the second list, the subject was presented with the list of words, and instructed to name the first number between one and twenty that came to his mind. The subject was asked not to use any plan of naming numbers, such as frequent repetition of the same number, or naming odd or even numbers.

When each subject had completed the experiment, *i.e.*, had finished the forced recall twenty-four hours later, he was asked the following questions. (1) Did the numbers come with difficulty? (2) Were you aware of the letters that you had associated with these words when the words appeared? (3) Were you aware, while memorizing the two lists of pairs, that both a word and a number were being associated with each letter?

The attempt to inhibit the direct association that has been formed during the learning of the two lists by positive instructions to recall an item of a different class is considered the important innovation in method here. Thus, the instructions will inhibit the direct connection, $A-C$, by calling for an item of class B , where there is an item that has been mediately connected with A . If the mediate connections exist, this method should force them to appear. However, this procedure differs in other, perhaps equally, important respects from those used in previous experiments on the problem. For one thing, the basic associations between the two items and the common

one are learned by the present procedure, and, therefore, known to exist; whereas in the previous experiments a single exposure of the paired items was relied upon for the formation of the basic associations. Having the paired items memorized (or presented) in two separate lists is another point of difference from the older procedure, which presented all the items in one list. More subjects were used in the present experiment than were used in the previous studies. Any one subject was used only once in the present study; whereas in previous ones the same subjects were used in several experiments. And the number of paired items to a list is much larger than was used in any of the other experiments. These last two factors, namely, increased number of subjects and increased number of pairs, both should operate to decrease the chances of direct association between the non-common items, during learning or memorizing.

Results.—Table I shows the results obtained from this experiment. In this table the number of the subject is on the

TABLE I

Subject	No. of M.A.	Subject	No. of M.A.
1.....	0	11.....	1
2.....	12	12.....	1
3.....	1	13.....	2
4.....	2	14.....	1
5.....	4	15.....	0
6.....	0	16.....	0
7.....	0	17.....	1
8.....	0	18.....	1
9.....	2	19.....	1
10.....	8	20.....	0

left; the number of mediate associations, on the right. The mediate associations were those instances in which the stimulus word and the reaction number had both been associated with the same letter. Out of 400 associations, or forced recalls, only 37 were mediate, or 9.3 percent, and 20 of these mediate associations, or over half, were given by two subjects: number 2 and number 10.

The introspective results in the form of answers to the three questions were as follows. The subjects numbered 3, 9, 12, 13, 14, 16, and 19 answered the first question in the affirmative, *i.e.*, that the forced recall of numbers came with difficulty. Subjects 3, 5, 7, 8, 9, 10, 11, 12, 13, 15, 16, and 19 answered 'yes' to the second question, affirming that they were aware of the common letters when the words were presented. And in answer to the third question the following subjects reported that they were aware that both a word and a number were being memorized with the same letters during learning of the two lists: 2, 4, 9, 10, 11, 13, 16, 17, 20.

The significance of these introspective results will be discussed under the summary of results for the first four experiments.

Experiment 2

Procedure.—The procedure and material were the same as those used in Experiment 1, except that the lists were shortened to 16 pairs of items, and the forced recall was taken immediately after the learning of the second list. Ten subjects were used. These subjects were asked the same questions at the termination of the experiment.

Results.—Table 2 shows the number of mediate associa-

TABLE 2

Subject	No. of M.A.	Subject	No. of M.A.
1.....	0	6.....	0
2.....	1	7.....	0
3.....	0	8.....	0
4.....	0	9.....	1
5.....	1	10.....	2

tions given by each subject. Out of a possible 160 mediate associations, only 5 were mediate, or 3.1 percent.

In answer to the three questions, subjects 2, 3, and 4 reported that they had difficulty naming numbers during the forced recall. Subjects 2, 3, and 4 reported that they were aware of the letters during the recall test. (Subjects 5, 8, and 9 reported that they were aware of the letters in a few cases.) And subject 1 was the only one to report that he was aware of the common item factor during the memorizing of the two lists.

Experiment 3

Procedure.—Here the procedure was the same as in the two preceding experiments, except that the material was exposed for a longer period, 4 seconds, on large cards that were turned by the experimenter. One list, again, was made up of paired words and letters; the other, of paired numbers and letters. The common item was the response. There were 16 pairs to the list. Ten subjects were used. The forced recall, in which the subject was asked to recall numbers to words, was taken twenty-four hours later, as in Experiment 1.

After completion of the forced recall, the subject was asked the following two questions: (1) Did any of these numbers seem to 'belong' with the words with which they recurred? In other words, were any of the words and numbers closely associated? (2) Did you refer at any time during the recall to the associations that you formed yesterday?

Results.—The number of mediate associations made by each subject is indicated in Table 3. As can be seen in this

TABLE 3

Subject	No. of M.A.	Subject	No. of M.A.
1.....	1	6.....	0
2.....	4	7.....	3
3.....	1	8.....	1
4.....	4	9.....	1
5.....	0	10.....	2

table, out of a possible 160 associations (or forced recalls), 17 were cases of mediate association, or 10.6 percent.

In answer to the questions, subject 2 reported 'belongingness' in three cases; subject 4, in four cases; subject 7, in one case; subject 9, in two cases; and subject 10, in one case. All of these cases were correct, *i.e.*, mediate association, except one of those indicated by subject 9. In answer to the second question, only two subjects reported a reference to the associations made previously: (1) Subject 4 reported noticing in four cases, during learning, that a particular word and number were being associated with the same letter, and 'carried them over' to the following day; (2) subject 10 reported the same for the one association of which he was certain of 'belongingness.'

Experiment 4

Procedure.—The procedure was the same as that used in Experiment 3. In this experiment, however, the letters (common items) were in the position of response in the first list when paired with words, and in the position of stimulus when paired with numbers in the second list. Thus the first list was an *A—C* list, and the second one was a *C—B* list. Ten subjects were used; and recall of numbers to words was taken twenty-four hours later.

After completion of the forced recall, these subjects were asked the same two questions that the subjects of Experiment 3 were required to answer.

Results.—Table 4 shows the number of mediate associations given by each subject. Thirty-nine associations out of 160 were cases of mediate association, or 24.4 percent. However, all but three of these cases were made by three subjects: 2, 3, and 4.

TABLE 4

Subject	No. of M.A.	Subject	No. of M.A.
1.....	2	6.....	0
2.....	16	7.....	0
3.....	8	8.....	0
4.....	12	9.....	0
5.....	0	10.....	1

Subject 2, who recalled the correct number in every case, reported that he was aware while recalling that in each case the number and word had been associated with a common letter on the previous day. Of the eight mediate associations given by subject 3, seven were cases in which he knew that the number and word had both been associated with the same letter on the preceding day. And subject 4 reported that he was certain of the connection with a common letter in twelve of the sixteen cases; these twelve were the ones that his record shows as correct, mediate associations.

In answer to the first question, subject 1 reported 'belongingness' in four cases (one of which was mediate association); subject 5 reported one case; subject 6, three; subject 7, two. In answer to the second question, subject 1 reported that he was aware of the connection with a common letter on the preceding day in four cases (only one of which was correct); the remaining subjects (excluding, of course, 2, 3, and 4) denied any reference to associations formed on the preceding day. Many of the cases of belongingness were explained by the subject on a basis extraneous to the experiment.

Chance.—When the list of words was exposed to a subject in the above four experiments, he was instructed to name a number between one and twenty, inclusive. Now, on a basis of pure chance, the probability is one out of twenty that any one association will be correct (since only one of the twenty numbers has been connected with the same letter as the word). And regardless of how many associations, or guesses, were made, one twentieth, or 5 percent, of them should be correct associations. However, there are a number of differences between a pure chance situation and these experimental situations which would tend to increase this percentage, making the chances of correctness larger than 5 percent. For one thing, there is the possible prior connection between some of the words and some of the letters which would not exist in a pure chance situation. However, the chief one of these differences is that in the experimental situation repetition of the same number was inhibited (though not prohibited), while in the pure chance situation this favorable factor does not operate.

In order to determine more exactly what the psychological chance would be, the following control experiment was performed. The list of twenty words used in the experiments was read to a group of 144 individuals, who were under instructions to write down immediately upon hearing a word the first number between 1 and 20, inclusive, that came to mind (these instructions were made as nearly as possible like those that were used with individual subjects in the experiments). 2,880 controlled or forced associations were thus obtained, and 195 of them were found to be 'correct.' The percentage of correctness is 6.8. The average number of correct responses or associations per individual was 1.4, and the range was between 0 and 5. Only one person gave five correctly, however, and only 28 of them gave no correct numbers.

Summary of the Results Obtained in the First Four Experiments.—In Table 5 the results of the above four experiments

TABLE 5

Experiment	No. of Subjects	No. of Associations	No. of Mediate A	% of Mediate A
1	20	400	37	9.3
2	10	160	5	3.1
3	10	160	17	10.6
4	10	160	39	24.4

are summarized, including all of the subjects. The first column of this table contains the number of the experiment; the second column contains the number of subjects; the third column, the number of recall associations; the fourth column, the number of mediate associations; and the fifth column, the percentage of mediate associations. The total number of subjects is 50; the total number of recall associations is 880; the total number of mediate associations is 98; and the percentage of mediate association for all four experiments combined is 11.1.

If 6.8 be taken as the percentage of mediate association that chance would allow, then the objective results of three of these experiments show mediate association: Experiments

1 and 3 to only a slight degree; Experiment 4, a fairly large amount. Experiment 2, on the other hand, shows a percentage of mediate association much smaller than the percentage of correct associations in the control experiment. The records of the subjects in Experiments 2 and 3 are relatively consistent; 1 and 4, however, are characterized by a few atypically large records. Another noteworthy feature of these data is that the proportion of subjects giving zero mediate associations is much larger than to be expected on a basis of chance and much larger than the proportion of subjects giving no correct associations in the control experiment.

The important subjective results are based on the answers made to questions (2) and (3) in Experiments 1 and 2 and on the answers made to question (2) in Experiments 3 and 4. These questions were aimed at determining (1) whether *C* was ideationally present during the recall of *A—B*, and (2) whether *A* was ideationally present during the learning of *B—C*. In Experiments 1 and 2, both of these possibilities were sought for by questions (2) and (3). In Experiments 3 and 4, however, the latter possibility only was determined by question (2).

In Experiment 1, twelve subjects answered in the affirmative to question (2), *i.e.*, that *C* was ideationally present during the recall test; these subjects gave 20 of the total 37 mediate associations. Nine subjects answered in the affirmative to question (3), indicating the ideational presence of *A* during the learning of *B—C*; these subjects gave 28 of the total 37 mediate associations. Of the two atypical subjects, 2 and 10, subject 10 answered both questions in the affirmative, while subject 2 answered only to question (3) with affirmation. These data indicate that the second possibility of association between *A* and *B* with *C* present, *i.e.*, ideational presence of *A* during the *learning* of *B—C*, is the efficacious one. This conclusion is confirmed when we turn to the subjective data of Experiment 2, which did not show objective mediate association. Here, six subjects reported the ideational presence of *C* during recall of *A—B*, or affirmed question (2), while only one of the total ten subjects reported the presence of *A* during the learning of *B—C*, or affirmed question (3).

Of the ten subjects used in Experiment 3, two answered in the affirmative to question (2), *i.e.*, indicating the presence of *A* and *B* with *C* during the memorizing of the second list of pairs. These two subjects gave six of the total 17 mediate associations. In Experiment 4, four subjects answered in the affirmative; these four subjects gave 38 of the total 39 mediate associations obtained in the experiment. These data confirm the conclusion based on the subjective data of Experiments 1 and 2, namely, that the disparate items *A* and *B* are associated *through C* during the *learning* of the second list of pairs.

The two outstanding features of the objective results of these experiments are the large proportion of subjects giving no mediate association and, in contrast, the large amounts of mediate association as shown in the records of a limited few subjects, particularly subjects 2 and 10 in Experiment 1 and subjects 2, 3, and 4 in Experiment 4. And turning to the subjective data, we find that while all of these five subjects giving large amounts of mediate association are in the class of subjects that we assumed probably associated *A* and *B* during learning, three of the subjects giving no mediate association are also in that class. The probable explanation of this apparent contradiction is that the questions were aimed at determining a condition without which the association of *A* and *B* could not have occurred, namely, awareness of the common series of items in the two lists. However, it does not necessarily follow that all subjects who were aware of the relationship should have formed the connections of *B* with *A* through *C*. Some subjects reported that they were not aware of the fact that the same letters were being used in the two lists; some reported that they were aware of the common letters but made no attempt to connect the words and numbers. We may assume that the five subjects who gave large amounts of mediate association did make this attempt, while the three subjects giving no mediate association but reporting awareness did not make the attempt.

That such an attempt at associating *A* and *B* through *C* during learning would result in a large amount of mediate association was confirmed in the case of two subjects whose

records are not included in the table. These individuals were told specifically the nature of the set-up and instructed to attempt to connect the words and numbers accordingly. These subjects were put through the experiment in the same manner as the others. One of these subjects' records gave 7 instances of mediate connection out of a possible 20. The other's record was one of 16 mediate connections out of a possible 16.

The data of the four experiments justify the following conclusions:

1. For our experimental conditions, there is a tendency for two items to recur together when both have been previously associated with a common item. The occurrence of this objective type of mediate association is limited to a few individuals and to certain of the experimental conditions.

2. Such mediate recall is usually a function of the presence of the common item, and it generally occurs during the memorization of the second list. It is to be noted that the revival of the absent item by the presence of the common item is a case of backward association.

3. It is highly improbable that mediate recall ever occurs without the presence of the common item.

Experiment 5

Procedure.—In the experiments described thus far, mediate association has been tested with verbal material. In this experiment an attempt was made to test the concept with motor, or skill material. A card-sorting board with twenty-five compartments on each surface was used. The compartments were identically arranged on both sides. Two decks of twenty-five cards were made: one deck of numbers one to twenty-five, and another deck of twenty-five letters. Each of the slots on one side of the board was marked for a number; and each slot on the reverse side was similarly marked for one of the letters. The numbers and letters on the compartments were arranged in a random order. After brief instructions as to the nature of the performance, the subject sorted each of the two decks of cards over the board thirty times. The subject first sorted one deck thirty times, rested five minutes, and sorted the second deck thirty times. The deck of cards was shuffled by the experimenter before each trial. Half of the subjects sorted the letters first, half the numbers. Twenty-four hours later the subject was presented with the deck of numbers and told to pair each number with one of the lettered cards, which were arranged alphabetically on a table, on the basis of the common slot into which they were sorted the day before. During this procedure the board was not in sight. Ten subjects took part in this experiment.

Under these conditions, the numbers and letters were connected with the same

movements of sorting, both a letter and a number being connected with each particular movement. Another common factor was the same location in the visual pattern of the board. When the subject had finished pairing the numbers and letters he was asked to indicate the pairs the correctness of which he was certain and also to describe the method that he had used in pairing.

Results.—The significant data of this experiment consist of two figures for each subject: (1) the total number of correct pairings of numbers and letters, and (2) the number of correct pairings of which he was not certain. These data are shown in Table 6. Column I includes the number of the subjects;

TABLE 6

I	II	III
1	12	2
2	18	3
3	5	2
4	2	0
5	6	1
6	3	2
7	9	0
8	1	1
9	16	7
10	4	2

column II, the number of correct pairings; and column III, the number of correct pairings of which the subject was not certain. The ten subjects made in all 250 pairings of letters and numbers (25 per subject). Of these, 76 were correct on the basis of common slot, or 31.0 percent; and of these 76, 20, or 10.3 percent were cases in which the subject was not certain. On the basis of pure chance, 4.0 percent of the pairings would be correct.

The subjective reports indicated that the certainty with respect to particular pairs of letters and numbers was based on the definite knowledge that they had been placed in the same slots on the preceding day. (Thirty of these instances of certainty were correct.) The subjects' reports of the methods used in making the pairings indicate that they retained an image of the board and had made their pairings on the basis of inference from this. Thus, the pairs that had been sorted in prominent slots, such as the corner ones or the center slots in the side rows and columns, were rarely missed. The remaining items were paired by a process of elimination, in which the subject paired first the ones that he was most

certain of, and so on until the last few were pure guesses. None of the numbers and letters seemed to the subjects to 'belong' together.

The chief value of this experiment lies in the fact that it shows that rather large amounts of mediate association in the purely objective sense may occur under favorable circumstances. With reference to the mechanism involved, however, very little can be concluded. That most of the mediate associations in the objective data belong to the third class as previously defined is apparent. The subjects' reports indicate that the common items (slots) were present during the mediate associations (correct pairings). The number of correct pairings in which the subjects were uncertain, and, hence, in which the presence of *C* may be doubted, are due either to mediate association in the second sense or to chance. The proportion of cases is larger than that allowed by a pure chance situation. But there are a number of differences between this situation and pure chance, besides the element of certainty in some cases, which would increase the chances in the experimental situation. Chief among these differences is the method of pairing by elimination which was used by the subjects, and which would not operate in a pure chance situation.

Thus, we may conclude that this experiment offers no evidence from which mediate association in the sense given in definition (2), that is, without the presence of the common item, may be inferred.

Experiment 6

Procedure.—Lists of pairs of nouns were the materials used. Each list contained sixteen pairs, which were exposed in random order on a memory drum. The exposure time per pair was three seconds. The subjects were divided into two groups. The first group (the test group) learned two lists of pairs by the paired associate method described in Experiment 1. One list was a series of *A*—*C*'s; the other, a series of *B*—*C*'s. The *B*'s were related to the *A*'s as part to whole, each whole and its part being paired with the same common *C*. Thus, one list was a series of wholes paired with words; the other, a series of parts paired with the same words, a whole and its part in the other list being paired with the same common word. For example, one pair in the first list was 'house—dog'; and the corresponding pair in the second list was 'room—dog.' The subject learned these lists in succession, and immediately after completion of the second was presented with the list of single words representing wholes and instructed to name the first part that came to his mind. He was not told that parts and wholes made up the lists he had learned, but was merely told to recall with a whole-part set.

The second group (the control group) learned two similar lists of paired nouns. With the exception of sixteen different words which were substituted for the *C* items in the second list, the words were the same ones used in the test group. Thus, these subjects learned a list of wholes paired with words; and a second list of parts paired with different words, *i.e.*, a list of *A-C*'s and a list of *B-D*'s. The procedure followed with the control group was exactly the same as that of the test group. Twenty subjects were used in each group.

The following whole-parts were used in this experiment: shool—class, tree—leaves, car—fender, road—curb, table—leg, camera—lens, hat—band, office—desk, house—room, lamp—shade, dresser—drawer, shoe—string, gun—trigger, horse—neck, piano—key, skate—wheel. Most of these are more or less closely associated in everyone's mind; and if an individual were given the list of wholes and instructed to name parts, he would undoubtedly name several of the parts that are paired in this list. The assumption upon which this procedure is based is that if any difference is found in the number of correct associations given by the two groups it can only be caused by the one difference between the two groups, namely, that in the test group the whole and part are associated with a common item while the same whole and part are associated with different items in the control group. In other words, the difference would be the effect of mediate association.

In this experiment introspective reports, in the form of answers to definite questions, were taken for the test group only. If *C* is reported as present, this fact indicates the truth of the third definition. If *C* is reported as absent, then, presumably, the second definition is true.

Results.—The results of this experiment are presented in Table 7. The first column of this table gives the number of subjects in the test group; and column two, the number of

TABLE 7

Test Group		Control Group	
Subject	No. of M.A.	Subject	No. of M.A.
1.....	7	1.....	8
2.....	10	2.....	8
3.....	15	3.....	5
4.....	15	4.....	9
5.....	11	5.....	8
6.....	8	6.....	6
7.....	5	7.....	7
8.....	13	8.....	6
9.....	11	9.....	5
10.....	14	10.....	5
11.....	4	11.....	6
12.....	10	12.....	8
13.....	9	13.....	8
14.....	10	14.....	6
15.....	9	15.....	6
16.....	14	16.....	4
17.....	14	17.....	5
18.....	13	18.....	4
19.....	13	19.....	5
20.....	9	20.....	8
Total.....	214		127
Average.....	10.70		6.40
Sigma.....	3.12		1.49

correct associations given by each subject. The third column gives the number of subjects in the control group; and the fourth column, the number of correct associations given by each subject. The average number of correct associations for the test group is 10.7, while the control group has an average of 6.4 correct associations. The difference between these means is 4.3; the sigma of the difference is .774. Hence, the difference between the means is 5.5 times as large as the sigma of the difference. This reliable difference is objective evidence of mediate association in the sense of the first definition.

The answers that the subjects of the test group made to the following questions comprise the subjective data obtained in this experiment. (1) Did the parts come with ease? Only five of the twenty subjects failed to answer in the affirmative. These subjects are numbered in the table: 4, 5, 7, 11, and 15. (2) Were you aware during the memorizing of the two lists of pairs that one series of words was common to both, and that you were associating two different words with each of these common words? Every subject in the group answered this question in the affirmative. (3) During the learning of the second list of pairs, were you aware of the whole-part relationship existing between one series of words in each list? Every subject but one answered this question with the affirmative. This exceptional subject is numbered 8 in the table. (4) During the recall test, that is, during the naming of parts to wholes, were you aware of the words which you had previously associated with the wholes? Only six subjects answered this in the negative; they are numbered in the table: 1, 6, 8, 10, 11, 19.

These subjective data indicate the strong probability that the wholes and parts were associated through the common words during learning, *i.e.*, that the mediate associations occurred during learning with *C* present. Undoubtedly the whole-part relationship between the items facilitated their association during the learning of the second list of pairs. This factor in conjunction with two others accounts for the larger amount of mediate association being evinced in this experiment than was evinced in the preceding experiments.

These additional two factors are the meaningful nature of the material used in this experiment and the already existing connections between the items.

From the data of this experiment it may be concluded that mediate association in the objective sense occurs in large amounts under favorable circumstances. These data also indicate the occurrence of mediate association in the sense of the third definition: namely, that when two items are associated with a common item an association is mediated between them by the presence of the common item.

PART II

The remaining experiments that were performed on this problem are included in a part separate from the above experiments, because an altogether different method was used. Whereas in the previous experiments it was assumed that if a weak association existed between two items, forced recall would be influenced by that fact, in these experiments it is assumed that if a weak association exists between two items, they will be easier to learn together. Thus, these experiments are based on the following assumption: that if an associative connection is formed between two disparate items by virtue of their direct association with a common item, these two disparate items should then be easier to memorize than otherwise. This is essentially the same logic that is behind Ebbinghaus' test for remote association.

According to this method, the subjects are divided into groups and each group learns three lists of paired associates. The first two lists are the same for both groups: every pair in both lists consists of a non-common item and an item common to a pair in both lists, *i.e.*, the first two lists correspond to those used in the experiments described under part one. The third list is different for the two groups: (1) for the test group it is a list formed by pairing the non-common items from the first two lists on the basis of the common item; (2) for the control group, the third list is made up of the non-common items from the first two lists paired at random. Thus, the items used in the third problem are the same for both groups, the difference being that these items are paired differently.

If the test group learns the third list with greater facility than the control group, this can only be due to the already existing mediate connections between the items in the test group's third list.

Experiment 7

Procedure.—Simple, geometrical figures were used as materials in this experiment. The figures were drawn on cards which were exposed on a Guhin automatic multiple-exposure apparatus. Each list was made up of a series of paired figures. A pair consisted of a large and a small figure, the larger circumscribing the smaller. The exposure time was approximately four seconds per card (and per pair). The subjects were instructed to associate the larger with the smaller figure. After each exposure of the complete series of cards, the subject was presented with a sheet of paper on which the large figures only were mimeographed. The subject drew inside of these as many of the small figures as he could remember. The exposures of the series of cards were continued until the subject could draw all of them correctly and inside of the appropriate large figure. The same procedure was followed with all three lists, all of which were learned successively.

The first two lists, which were the same for both groups, contained ten pairs of figures. The smaller, inside, figures were common to both lists; the larger figures were different. Hence, the common items in these two lists were the responses. The third series was also made up of ten large and small figures, the large ones being the large figures used in the second series, the small ones being the large figures of series one. These figures were paired differently for the two groups. For the test group, they were paired according to the common small figure in the first two lists. For the control group, they were paired at random. Twenty-six subjects were used in each group.

At the completion of the experiment each subject was questioned far enough to determine whether he was aware during learning that common figures were being used or whether his idea of the nature of the set-up of the experiment was very definite.

Results.—In Table 8 the results in terms of trials (T) and errors (E) to memorize the three lists to a criterion of one

TABLE 8

Problem	I		II		III	
	T	E	T	E	T	E
Total—T. G.....	167	781	126	503	161	678
—C. G.....	166	724	117	467	120	415
Ave.—T. G.....	6.42	30.04	4.85	19.35	6.19	26.08
—C. G.....	6.38	27.85	4.50	17.96	4.62	15.96
Sigma—T. G.....	2.59	17.09	1.09	5.42	2.10	11.75
—C. G.....	2.87	19.75	1.72	9.88	1.27	7.51

perfect recall are given. In this table 'T. G.' stands for test group, and 'C. G.' for control group. The second row includes the total trials and errors for all three lists; the third

row includes the average trials and errors; and the fourth row, the sigma of the distribution. The differences between the two groups (test and control) for the first two lists are small and unreliable. For the third, however, the differences between the two groups are large, and are also reliable. In terms of trials: the difference is 1.57; the sigma of the difference is .48; and the difference is 3.30 times as large as the sigma of the difference. In terms of errors: the difference is 10.12; the sigma of the difference is 2.73; and the difference is 3.70 times as large as the sigma of the difference. These differences, contrary to expectation, are in favor of the control group, instead of the test group. Therefore, on the basis of these results, it is more difficult to connect two items that have been associated with a common item than it is to connect two items that have been associated with different items.

Some of the subjects used in this experiment were aware that a set of figures was common to the two lists, but they could not specify which figures these were. Only one subject was aware of the nature of the arrangement of the figures in the three problems, and he was in the control group. His data were not discarded, because they showed no effects of the knowledge. Most of the subjects were surprised when informed that the small figures used in the first two lists were the same. Thus, there is little room for doubting that these subjects (with one exception) did not ideationally connect the larger figures in the first two problems through the common smaller ones.

The reports of these subjects expressing complete ignorance as to the arrangement of the pairs, contrasts sharply with the reports of the subjects in the preceding experiments. The nature of the materials undoubtedly accounts for the difference. Most of the figures used in the lists were nonsensical in shape and, therefore, defied ideation. Hence, during the learning of the second list it was impossible for the larger figures (*A*'s) of the first list to be ideationally present and then associated with the large figures of the second list (*B*'s).

The conclusions of this experiment are negative for all of the three possible definitions of mediate association stated in the introduction.

Experiment 8

Procedure.—Peterson Rational Learning problems were used as materials in this experiment. These problems are composed of lists of paired items and, therefore, lend themselves easily to experimentation on association. The problems used in this experiment were twelve pairs in length. As in Experiment 7, the subjects were divided into two groups, and each group learned three lists. For the first list, the stimulus items were the months of the year, and the response items were the numbers 1 through 12. For the second, the stimulus items were the months of the year, and the response items were the letters A through L. For the third, the stimulus items were the numbers 1 through 12, and the response items were the letters A through L. The letters and numbers in the third list were paired differently for the two groups: with the test group they were paired according to the common month in the first two lists; with the control group they were paired at random.

The criterion of learning for all three lists was two perfect trials in succession. During the learning of each problem, the stimulus items were read to the subject in random order to avoid place associations. Twenty-three subjects were used in the test group; and twenty-four in the control.

This experiment differs from Experiment 7 in two respects: a different type of learning material is used, and the common items are in the position of stimulus in both lists, instead of response, as they were in Experiment 7. After completion of the third list, each subject was questioned in order to determine whether he had thought of the possibility of the letters and numbers in the first two lists being paired according to the common month in the third list. And also whether he had made any attempt to connect the letters and numbers accordingly during the learning of the second problem. Only four subjects answered these questions in the affirmative, and their records were discarded.

Results.—The first row in Table 9 shows the total trials and errors for the test and control groups on the three problems. The second row contains the averages; the third row, the standard deviations; the fourth row, the differences between the averages of the two groups; the fifth row, the standard error of the difference; and the last row, the difference divided

TABLE 9

Problem	I		II		III	
	T	E	T	E	T	E
Total—T. G.....	152	558	125	408	130	487
—C. G.....	137	503	126	419	134	485
Ave.—T. G.....	6.61	24.26	5.43	17.74	5.65	21.17
—C. G.....	5.71	20.96	5.25	17.46	5.58	20.21
Sigma—T. G.....	2.32	13.50	1.41	6.30	1.40	7.64
—C. G.....	1.43	8.09	1.62	7.41	1.47	9.85
Difference.....	.90	3.30	.18	.28	.07	.96
Sigma D.....	.56	3.26	.44	2.00	.42	2.56
D/sigma D.....	1.61	1.01	.41	.14	.17	.38

by the standard error of the difference. These differences are all small, and none of them is very reliable.

Therefore, the conclusions of this experiment are negative for all three possible definitions of the concept of mediate association.

The reports of the four subjects whose data were discarded furnish an interesting qualitative result to this experiment. When they were informed that the third problem was composed of a list of numbers and letters, they suspected that the pairing would be on the basis of a common month in the first two problems. Two of these subjects were on the control group and two on the test group. The two on the control group found that their suspicion was not true and finished the third list with an average record. The two on the test group, however, found that their suspicion was true and proceeded to learn the list by intentionally using the common item. Their records, in terms of trials, for the third problem were below the average for that list, and much longer than their records for the first two problems. In other words, it is more difficult to try to learn the list consciously by common item than merely to learn the list. One of these subjects made the statement that for him the numbers and letters were not associated at all; that he had to go each time from number to month and thence to letter. This fact is entirely congruous with the tendency implied in the results of Experiment 7: namely, that items that have previously been associated with the same item resist association themselves.

Experiment 9

Procedure.—The same procedure and materials that were used in Experiment 8 were also used in this experiment. The only difference between the two was that the lists learned in this experiment were arranged so that the common items, the months of the year, were the responses in the first problem and the stimuli in the second problem, while in Experiment 8 the common items were the stimuli for both problems. Twenty-five subjects were used in each group.

When the experiment was finished, these subjects were questioned in the same manner as those in Experiment 8. The records of three were discarded.

Results.—Table 10 is constructed on the same plan as Table 9. The differences between the test and control groups

TABLE 10

Problem	I		II		III	
	T	E	T	E	T	E
Total—T. G.....	152	632	147	586	136	522
—C. G.....	162	753	150	659	144	613
Ave.—T. G.....	6.08	25.28	5.88	23.44	5.44	20.88
—C. G.....	6.48	30.12	6.00	26.36	5.76	24.52
Sigma—T. G.....	.84	6.80	.95	7.48	1.03	7.05
—C. G.....	.90	10.14	1.13	8.95	.95	7.92
Difference.....	.40	4.84	.12	2.92	.32	3.64
Sigma D.....	.25	2.44	.30	2.34	.28	2.12
D/sigma D.....	1.60	1.98	.40	1.24	1.14	1.71

are all small and unreliable. Hence, the objective data of this experiment show no tendency toward mediate association.

This experiment confirms the results of Experiment 7 and 8. When the connection between *A* and *B* is tested by the method of relearning, there is no mediate association of any type.

III. SUMMARY AND CONCLUSIONS

The concept of mediate association assumes that two items that have been directly associated with a common item are, therefore, indirectly associated, and that this indirect or mediate connection will manifest itself in a tendency for the two items to recur together in *recall*. This has been tested in six experiments. In each of these experiments the previous functioning of the two items with a common one was insured by requiring the subjects to learn lists of common and non-common items to a definite criterion.

In these experiments, the test for the connection between the disparate items, or the effects of mediate association, was one of *forced* recall. The objective results of these experiments are: a positive effect in Experiments 1, 3, 4, 5, and 6; and no effect in Experiment 2. The subjective results consisted of reports on the part of the subjects indicating (1) whether or not the common item was ideationally present during recall, and (2) whether or not the disparate (non-common) items were associated during the learning of the second list. In both Experiments 1 and 2, a large proportion of the subjects reported that the common item was present during recall; a

large proportion of subjects in Experiment 1 and only one subject in Experiment 2 reported that the disparate items were associated during learning. The second factor is, therefore, the important one, since Experiment 1 offered positive effects and Experiment 2 offered no effects. The conviction that the disparate items were associated during learning of the lists, particularly the second list, is confirmed by the reports of the subjects of Experiments 3, 4, 5, and 6.

In the three remaining experiments, *relearning* was used as a test for the effects of mediate association. The objective results of these experiments are: no effect in Experiments 8 and 9, and a negative effect in Experiment 7. The subjective data of these experiments indicate that the non-common items were not associated during the learning of the second list.

All conditions were not held constant in the whole nine experiments. The following five conditions varied deserve special mention:

1. The position of the common items in the two lists that were learned, thus establishing the basic, primary associations. The common items occupied the position of response in both lists in Experiments 1, 2, 3, 5, 6, and 7. One of these experiments (number 6) gave a very large amount of mediate association; three of them (1, 3, 5) showed positive effects; number 2, no effect; and Experiment 7 showed a negative effect. The stimulus was the common item in Experiment 8, which showed no objective effects. The common item was the response in one list and the stimulus in the other in Experiments 4 and 9. Experiment 4 showed positive effects; Experiment 9 showed no effect. Apparently, there is no consistent correlation between position of common item and mediate association.

2. The time interval between the learning of the two lists and the test for mediate association. This test was taken immediately after learning in Experiments 2, 6, 7, 8, and 9. A twenty-four hour interval was interpolated between learning and test in Experiments 1, 3, 4, and 5. Apparently, the effects of mediate association vary independently of this time interval.

3. The nature of the learning material. In the first place, memory (or verbal) material was used in every experiment but number 5. In this experiment a manual skill was used. The results of this experiment indicate to a high degree the effects of mediate association. The subjective reports indicate that the common items were verbalized, or carried in terms of ideas; thus, no conclusion can be drawn as to the influence of acts of skill as opposed to memory.

In the second place, the memory materials used in these experiments vary in degree of meaningfulness. The most meaningful materials were used in Experiment 6 (words in whole-part relationship); and this experiment yields the greatest amount of mediate association. Meaningful materials (words, letters, numbers) were used in Experiments 1, 2, 3, 4, 8, and 9; three of these show a positive effect and three no effect at all. Non-meaningful material (geometrical figures) was used in Experiment 7; and this experiment shows a negative effect. Thus, there is a tendency for the objective effects of mediate association to vary directly with degree of meaningfulness. Since meaningful material lends itself to ideation more easily than non-meaningful, this correlation could be inferred from the subjects' introspective reports.

4. The nature of the test used. The recall method was used as a test in the first six experiments; the relearning method, in the last three. Five of the first six experiments gave positive effects; only one experiment showed no effect. Two of the remaining experiments gave no effect; one showed negative effects. Thus, when the recall method is used, mediate association occurs; when the relearning method is used, it does not occur. According to the first method, the subject was presented with an item and instructed to name another item; in the second, he was presented with two items and told to connect, or memorize, them. In the former method, the subject is likely to cast about for some method of choosing an item to name. This would be association, but it might just as well be *through* the common item. In the second case, this possibility of choice is eliminated.

5. Individual differences in the matter of mediate associa-

tion are apparent. While the records of most subjects in the first six experiments show either no cases or very few cases of mediate association, a limited number of subjects gave a surprisingly large number of cases. These exceptions are, undoubtedly, due to individual differences in ideation, especially during learning. Some individuals, when learning, attempt to make only direct associations between successive items; others are thinking during learning, trying to detect indirect relationships. And this variation in type probably reduces to a fundamental difference in individuals very similar to the difference between the 'tough' and 'tender' minded individuals described by James.

The factors that favor mediate association are those that favor ideation. When two items have previously been associated with a common item, they later are associated themselves, because the presence of the common item, either sensory or ideational, has brought them together. Thus, the association is mediated *through* the presence of the common item.

Conclusions.—Any conclusions concerning the existence of mediate association will naturally vary with the definition adopted.

1. If the concept be defined as the tendency for the two items to recur together in recall, because they have previously been associated with a common item, the existence of this kind of mediate association is proven by our data.

2. If the term be defined as a tendency for one item to arouse the other in recall when the common item is not present at the time, the concept is false.

3. The third possible definition assumes that one of the two items will arouse the other when the common item is perceptually or ideationally present at the time of recall. Our data support the truth of this concept.

The results of one of our experiments indicate that, when the relearning method and non-meaningful material are used, there is a tendency opposite to that of mediate association, *i.e.*, that when two items have been directly associated with a common item, they resist direct association themselves.

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